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Daniel Walker

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Univ of Hawaii
Hawaii Institute of Geophysics
2525 Correa Road, Honolulu HI 96822

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An additional year of data was acquired from the Wake Island hydrophone array for use in a wide variety of research topics including underground nuclear testing and studies of surface generated water column noise and ocean bottom noise. A new, efficient recording system was installed, tested and proven effective. Progress in dissertation research continued and some additional needed support and interest was provided by other agencies.

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Introduction

The Wake Island hydrophone array consists of ocean bottom and SOFAR hydrophones with an aperture of 318 km. Detailed descriptions have been given in earlier AFOSR technical reports and in journal publications (McCreery and Walker, 1985). Data from the array has been used for: (1) research on high-frequency Po, So phases (Walker, 1984) which are a result of propagation in the most efficient acoustic waveguide in the solid earth (Walker et al., 1978; Butler et al., 1987); (2) the detection of otherwise unreported earthquakes in the interior of the Northwestern Pacific Basin (Walker and McCreery, 1985; Kroenke and Walker, 1986; Walker, 1989); (3) the postulation of a newly forming subduction zone in the southwest Pacific (Kroenke and Walker, 1986); (4) the detection of episodes of submarine volcanism (Walker et al., 1985; Eos, 7 Nov. 1989); (5) studies correlating ocean surface wind and rain with ocean bottom noise levels (McCreery, attached abstract); and (6) studies of underground nuclear explosions (Walker, 1980; McCreery et al., 1983; McCreery and Walker, 1985).

The hydrophones were found to be especially useful for studies of underground nuclear explosions because of: (1) the extreme low noise of the ocean floor at frequencies in excess of 3 Hz; (2) the richness of high frequency energy in P phases from explosions recorded at great distances by the Wake hydrophones; (3) the location of most test sites in the highly efficient propagational distance range of 60° to 90° from Wake; and (4) the nearly identical epicentral distances to Wake of three active and geologically diverse test sites – Nevada, E. Kazakh, and the Tuamotu (French Polynesia) test site.

Objectives

Subsequent to rapid and dramatic political changes affecting nuclear test studies, the objectives of this grant were to: (1) provide continued support for a graduate student (C.S. McCreery) who began his dissertation research with the Wake data; (2) continue operation of the array so that additional necessary data could be acquired for his dissertation; and (3) adequately test an upgraded recording system which could provide

lower cost recordings more amendable to processing, thereby enhancing opportunities for funding a wide variety of research projects by other agencies.

Results

C.S. McCreery continued progress towards the completion of his degree. Parts of his future dissertation will be presented at an upcoming meeting in San Francisco of individuals studying ocean noise (attached abstract). During the grant period an additional year of data was acquired which will form an important component of McCreery's dissertation. During the grant period an upgraded recording system was installed with support provided by ONR and the State of Hawaii. Features of the upgrade included: (1) video cassette recording which permits the storage on a single tape of signals with frequencies as high as 40 Hz from 16 channels recording continuously for a week; and (2) improved long-period low noise amplifiers. We estimate that the upgraded system will lower annual operation and processing costs from about $25,000 to $2,400. An example of a hydroacoustic phase recorded and processed with upgraded hardware and software is shown in Figure 1. Finally, we have been successful in securing some interest and support from NOAA for additional operation of the Wake array to monitor hydroacoustic signals from Pacific-wide ridge systems and from ONR for continuing studies of surface generated water column noise and ocean bottom noise.

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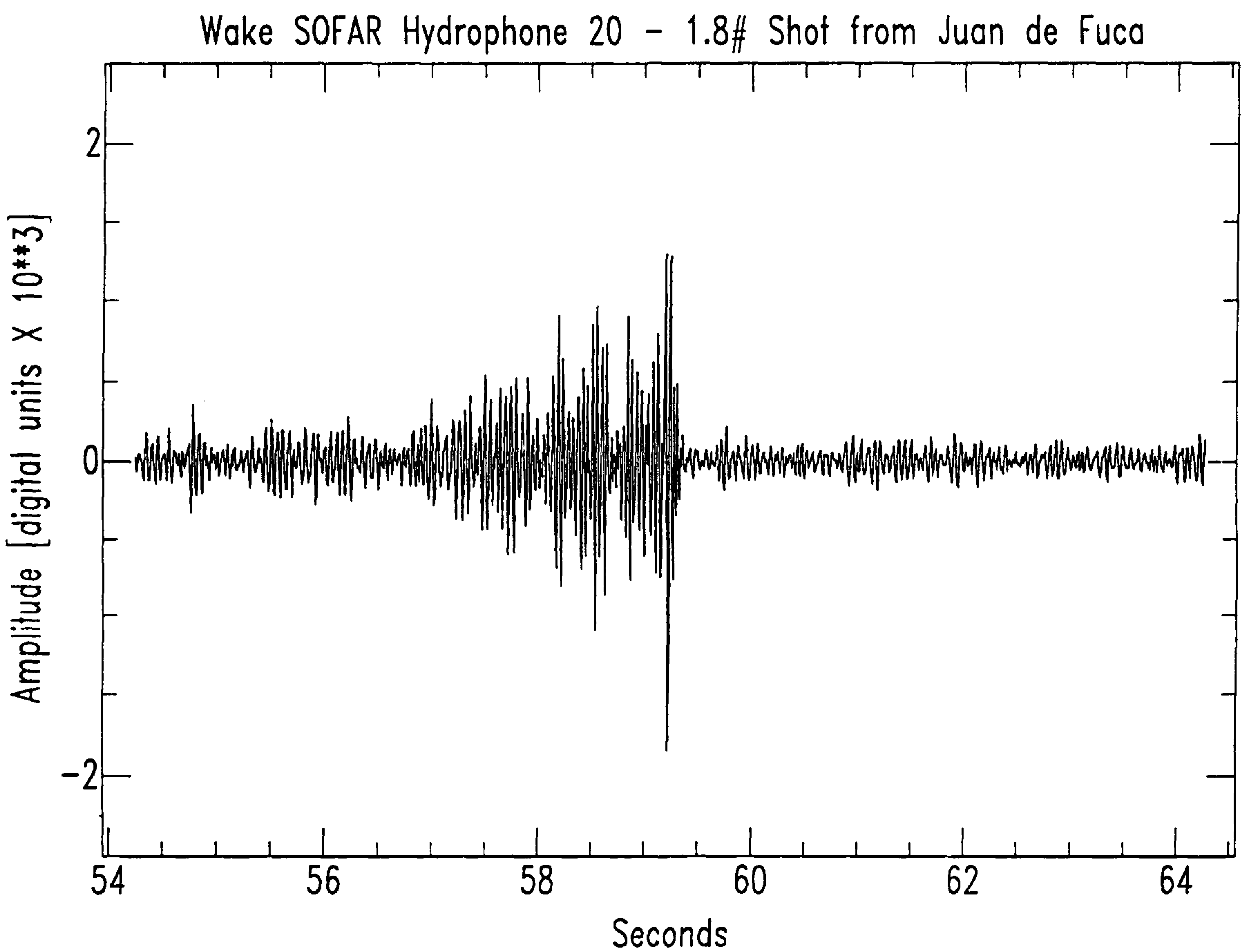

Fig. 1. Wake Island hydrophone recording of a small 1.8 lb explosion in the water column off the Coast of Oregon. The distance to the hydrophone is about 6500 km and the travel time is about 72 minutes.

Long-Term Ambient Ocean Noise, 0.05-30 Hz, From Wake Island Hydrophones

C S McCreery, F K Duennebier, D A Walker, and T A Schroeder (all at the School of Ocean and Earth Sciences and Technology, University of Hawaii, Honolulu, HI 96822)

Variations of 0.05-30 Hz ambient deep-ocean hydro-acoustic noise near Wake Island from 1982 to 1990 have been quantified and compared to local weather and estimated sea surface conditions. Noise measurements are from an array of twelve hydrophones, six on the deep ocean bottom to the north of Wake at 5.5-km depth, and six at three sites to the south and west of Wake at 1-km depth (the SOFAR-axis depth). Local weather conditions are from National Weather Service monthly summaries for Wake, satellite weather maps, and annual typhoon summaries. Estimated sea surface wave data are from the Navy's Spectral Ocean Wave Model (SOWM) and Global Spectral Ocean Wave Model (GSOWM). Noise variations above 0.5 Hz correlate strongly with local winds, and are probably related to the locally-generated short-period ocean waves (0.5-5 Hz noise), and to wave breaking (5-30 Hz noise). Noise variations below 0.5 Hz have a rich character, with levels often rising or falling in relatively narrow frequency bands over time periods ranging from days to weeks. These narrow bands sometimes exhibit a shift in frequency, up or down, over time. This longer-period noise is compared to the SOWM and GSOWM sea wave data at corresponding frequencies. Punctuating the longer-term noise variations are earthquake surface waves, 0.05-0.15 Hz, that generally last for a few hours. Typhoons passing near Wake generate noise over the entire frequency band, and extreme noise levels were observed during the passage of Typhoon Doyle directly over the deep Wake hydrophones.